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PROGRESS REPORT MIT Space Grant Program

I. Shapiro, PI; S. Baliunas Co-I

S. Baliunas and SAO Postdoctoral fellows R. Donahue and W. Soon worked with two high-school students and two undergraduate students on the analysis of stellar data. The data were obtained with the Automated Photoelectric Telescope (APT) at SAO's Whipple Observatory in southern Arizona, and the Mount Wilson 60-inch telescope in California.

The APT is completely automated, and is accessed remotely via Internet or modem. The APT is jointly managed by Baliunas and colleagues and students at Tennessee State University, an HBCU which is a partner in the Tennessee Space Grant Consortium. TSU participation is funded independently by NASA and NSF.

Ms. Fiona McMillan, from Furman College in South Carolina, worked with the acquisition and analysis of magnetic activity data on solar-type stars. McMillan spent 10 weeks working at Mount Wilson Observatory last summer, and made measurements, reduced data and analyzed the data. She is working with us on a manuscript of her research on the Sun's long-term magnetic behavior. By choosing suitable stars that are similar to the sun in its physical properties, she was able to infer the long-term variations of the sun, including the state of the sun during the Maunder Minimum of the 17th century, when few sunspots and no evidence for the 11-year cycle were observed.

Mr. Ken Kobayashi, from Harvard University, worked with adaptive optics data from the 60-inch telescope at Mount Wilson and the Atmospheric Compensation Experiment (ACE). Kobayashi helped develop software to make automatic analysis of adaptive optics data and automatic comparison with simultaneous meteorological data. The comparison helps assess the performance of ACE for astronomical applications. These results are being prepared for publication.

Two exceptional high-school students were provided by MIT's RSI summer program, and the students were comparable to undergraduates in ability. Both students analyzed several of the variable stars that have been observed photometrically with the APT since 1987, and prepared manuscripts that will shortly be submitted for publication.

Mr. H.-J Choi topic was,"Rotation and Magnetic Activity of Evolved Late-type Stars." Choi analyzed stars that have both magnetically bright ("plage") and dark ("starspot") regions, as the Sun does. However, the stars Choi analyzed have exhausted hydrogen as a nuclear fuel in the core, and become post-main sequence red giants. Choi compared the variations of the magnetically bright and dark areas; the latter features show up in the APT data. Choi found the magnetic activity in red giants shows traits in common with main sequence stars, and so share a magnetic dynamo mechanism with the Sun, despite the great differences in their physical properties. In addition, Choi analyzed the level of precision of the APT data, and determined upper limits of detecting variability with the instrument.

Ms. C. V. Cristina discussed "Pulsation Periods and Amplitudes of a Sample of Semi-regular Variables." These are cool (MO III) post-main sequence stars that are varying due to interior instabilities. The variations are likely associated with shock waves as a result of somewhat periodic pulsations. Cristina discovered dominant pulsation periods in the range of 10 to 250 days in the eight years of data analyzed. Many

stars showed multiple periods to persist for several years.

Manuscripts will be submitted to *Publications of the Astronomical Society of the Pacific*. Copies of the manuscripts will be sent under separate cover.

S. Leiker, with the CfA's MicroObservatory program, worked on the integration of several different local sources of astronomical data on variable stars: the CfA's APT's, MicroObservatory and the AAVSO (American Association of Variable Star Observers) project funded by NSF, "Hands-on Astrophysics." The AAVSO has a substantial and long-running data base of visual magnitude estimates of variable stars that contains a wealth of information on the history of stellar variations going back to 1911. Leiker discussed with Drs. Janet Mattei and John Percy at the AAVSO several times about the possibility of combining the goals, methods and data of the APT, MicroObservatory and the AAVSO projects. Leiker began observations with MicroObservatory of several stars that are being observed by AAVSO in order to assess the suitability of combining both types of data. The data from the APTs will be given to some of the better students of the AAVSO project, since for the most part they will have only visual data.

The AAVSO is developing a friendly program for the PC that will allow students to graph photometric data and do some different types of analysis. This software, when finished, will be available for student use free/or very low cost. It would be useful for graphing visual (AAVSO), CCD (MicroObservatory), and APT photoelectric data. The software will also be integrated with database/spreadsheet programs for both Mac and PC which will help students look at their data. Leiker studied astronomical Image processing programs for both the Mac and PC.

As part of the commitment in last year's proposal to outreach, Leiker worked with two high-school teachers on the possible use in the classroom of the variable star data. One teacher, from the Watertown public schools, thought the program was too difficult for most of the students. The other teacher, from the Brooks school in Andover, thought a few students per year would be able to and interested in working on a variable star project.

J. Lockwood, science teacher at Sugaro High School in Tucson, Arizona, again successfully used the APT data in the classroom. Pairs of students conducted library research on a variable star, then analyzed the data and wrote research reports on their results compared to results from earlier scientists.